

Periodic Table

Chapters 4, 5, 6

A. The Periodic Table

QUESTION: Why is the periodic table arranged this way?

| | | GROUPS | | | | | | | | | | | | | | | | | |
|---------------------|-----|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|-----------|-----------|----------|----------|----------|----------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| PERIODS | 1 → | 1 H | | | | | | | | | | | | | | | | | 2 He |
| | 2 → | 3 Li | 4 Be | | | | | | | | | | | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne |
| | 3 → | 11 Na | 12 Mg | | | | | | | | | | | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar |
| | 4 → | 19 K | 20 Ca | 21 Sc | 22 Ti | 23 V | 24 Cr | 25 Mn | 26 Fe | 27 Co | 28 Ni | 29 Cu | 30 Zn | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr |
| | 5 → | 37 Rb | 38 Sr | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |
| | 6 → | 55 Cs | 56 Ba | 57 La | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| | 7 → | 87 Fr | 88 Ra | 89 Ac | 104 Rf | 105 Db | 106 Sg | 107 Bh | 108 Hs | 109 Mt | 110 Uun | 111 Uuu | 112 Uub | | | | | | |
| 6th-period subset → | | 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | 71 Lu | | | | |
| 7th-period subset → | | 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No | 103 Lr | | | | |

| | | | | | | | | | | | | | | | | | | |
|---------------|----------|--|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|----------|----------|----------|----------|------------------------------|----------|
| | | | | | | | | | | | | | | | | | Noble gases ↓ 18 8A | |
| | | Alkaline earth metals ↓ 1A 2A | | | | | | | | | | | | | | | Halogens ↓ 17 7A | |
| Alkali metals | 1 H | 2 He | | | | | | | | | | | 13 3A | 14 4A | 15 5A | 16 6A | 17 7A | 18 8A |
| | 3 Li | 4 Be | | | | | | | | | | | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne |
| | 11 Na | 12 Mg | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar |
| | 19 K | 20 Ca | Transition metals | | | | | | | | | | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr |
| | 37 Rb | 38 Sr | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |
| | 55 Cs | 56 Ba | 57 La* | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| | 87 Fr | 88 Ra | 89 Ac† | 104 Rf | 105 Db | 106 Sg | 107 Bh | 108 Hs | 109 Mt | 110 Uun | 111 Uuu | 112 Uub | | | | | | |

*Lanthanides

| | | | | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | 71 Lu |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

†Actinides

| | | | | | | | | | | | | | |
|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|
| 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No | 103 Lr |
|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|

Periodic Table

| 1A | | | | | | | | | | | | | | | | | 8A |
|-------------------|-------------------|-------------------|--------------------|--------------------|---------------------|---------------------|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 1 H 1.008 | | | | | | | | | | | | | | | | | 2 He 4.003 |
| 3 Li 6.941 | 4 Be 9.012 | | | | | | | | | | | 5 B 10.81 | 6 C 12.01 | 7 N 14.01 | 8 O 16.00 | 9 F 19.00 | 10 Ne 20.18 |
| 11 Na 23.00 | 12 Mg 24.31 | | | | | | | | | | | 13 Al 26.98 | 14 Si 28.09 | 15 P 30.97 | 16 S 32.06 | 17 Cl 35.45 | 18 Ar 39.95 |
| | | 3B | 4B | 5B | 6B | 7B | 8B | | | | 1B | 2B | | | | | |
| 19 K 39.10 | 20 Ca 40.08 | 21 Sc 44.96 | 22 Ti 47.90 | 23 V 50.94 | 24 Cr 52.00 | 25 Mn 54.94 | 26 Fe 55.85 | 27 Co 58.93 | 28 Ni 58.70 | 29 Cu 63.55 | 30 Zn 65.38 | 31 Ga 69.72 | 32 Ge 72.59 | 33 As 74.92 | 34 Se 78.96 | 35 Br 79.90 | 36 Kr 83.80 |
| 37 Rb 85.47 | 38 Sr 87.62 | 39 Y 88.91 | 40 Zr 91.22 | 41 Nb 92.91 | 42 Mo 95.94 | 43 Tc (98) | 44 Ru 101.1 | 45 Rh 102.9 | 46 Pd 106.4 | 47 Ag 107.9 | 48 Cd 112.4 | 49 In 114.8 | 50 Sn 118.7 | 51 Sb 121.8 | 52 Te 127.6 | 53 I 126.9 | 54 Xe 131.3 |
| 55 Cs 132.9 | 56 Ba 137.3 | 57 La 138.9 | 72 Hf 178.5 | 73 Ta 180.9 | 74 W 183.9 | 75 Re 186.2 | 76 Os 190.2 | 77 Ir 192.2 | 78 Pt 195.1 | 79 Au 197.0 | 80 Hg 200.6 | 81 Tl 204.4 | 82 Pb 207.2 | 83 Bi 209.0 | 84 Po (209) | 85 At (210) | 86 Rn (222) |
| 87 Fr (223) | 88 Ra 226.0 | 89 Ac 227.0 | 104 Rf (261) | 105 Ha (262) | 106 Unh (263) | 107 Uns (262) | | 109 Une (267) | | | | | | | | | |

Lanthanides

| | | | | | | | | | | | | | |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 58 Ce 140.1 | 59 Pr 140.9 | 60 Nd 144.2 | 61 Pm (145) | 62 Sm 150.4 | 63 Eu 152.0 | 64 Gd 157.3 | 65 Tb 158.9 | 66 Dy 162.5 | 67 Ho 164.9 | 68 Er 167.3 | 69 Tm 168.9 | 70 Yb 173.0 | 71 Lu 175.0 |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|

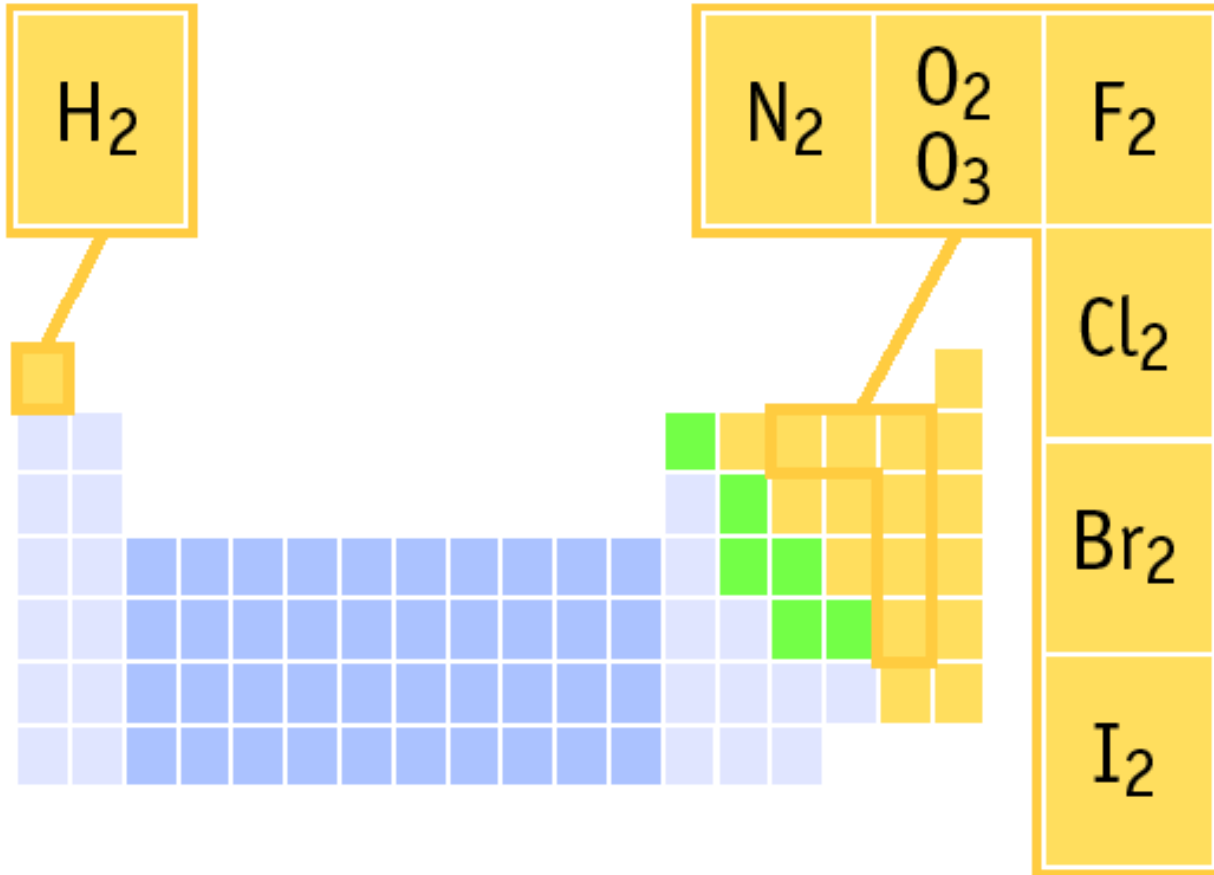
Actinides

| | | | | | | | | | | | | | |
|-------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|
| 90 Th 232.0 | 91 Pa 231.0 | 92 U 238.0 | 93 Np 237.0 | 94 Pu (244) | 95 Am (243) | 96 Cm (247) | 97 Bk (247) | 98 Cf (251) | 99 Es (252) | 100 Fm (257) | 101 Md (258) | 102 No (259) | 103 Lr (260) |
|-------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|

A. The Periodic Table

- Periods: rows across periodic table
- Groups: vertical columns in periodic table
 - 1-18 or 1-8;
 - we use 1-8 as they also show the number of valence (outer) electrons
- Divisions in periodic table:
 - Metals: left side of periodic table
 - Non-metals: right side of periodic table
 - Metalloids (semi-metals): there are seven. They have properties of metals and non-metals.

B. Elements that exist as diatomic molecules



These elements only exist as PAIRS. Note that when they combine to make compounds, they are no longer elements so they are no longer in pairs!

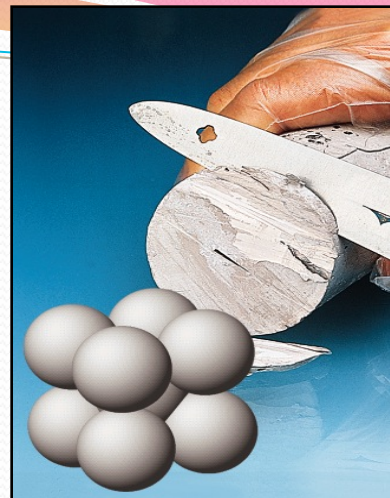
C. Hydrogen



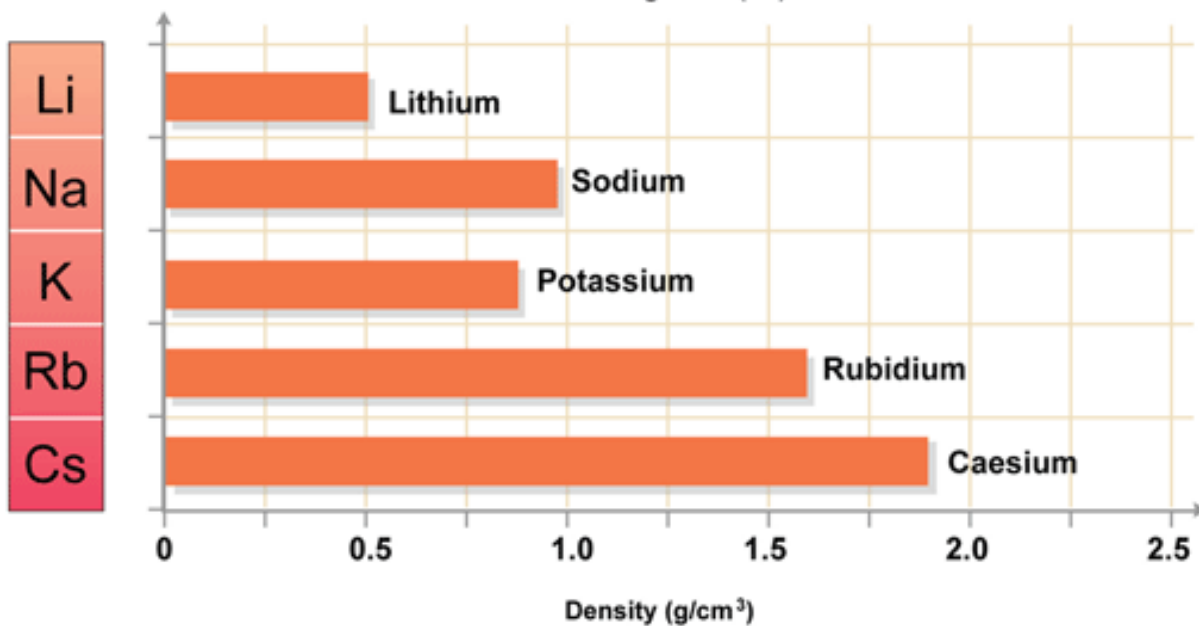
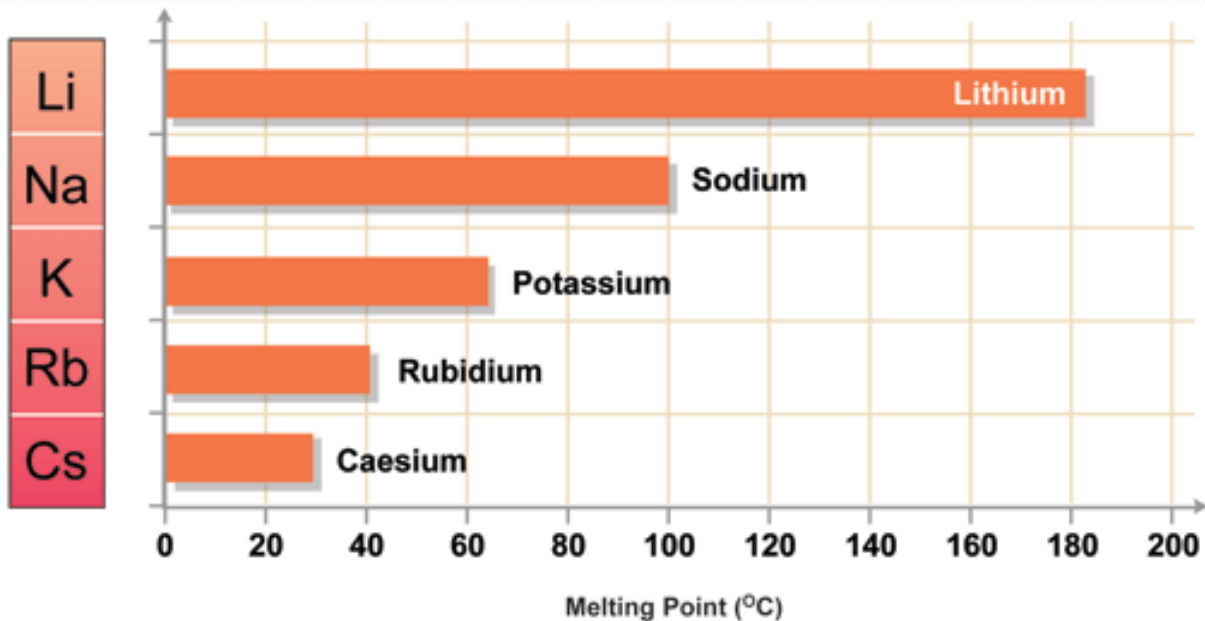
- Hydrogen belongs to a family of its own.
- Hydrogen is a diatomic, reactive gas.
- Hydrogen BOMB!!
- Hydrogen is promising as an alternative fuel source for automobiles

D. Alkali Metals

- 1st column on the periodic table (Group 1) not including hydrogen.
- Very reactive metals, always combined with something else in nature (like in salt).
- Soft enough to cut with a butter knife
- Low melting and boiling points (unlike other metals)
- Low density



D. Alkali Metals



D. Alkali Metals



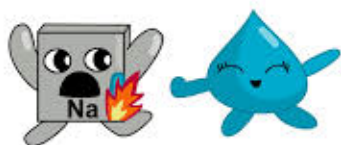
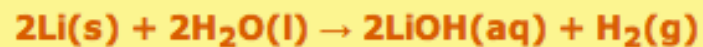
- All alkali metals react vigorously with cold water.
- In each reaction, **hydrogen gas** is given off and the **metal hydroxide** is produced (strong alkali is produced and hence why they are called alkali metals).
- The speed and violence of the reaction **increases** as you go down the group.
- This shows that the reactivity of the alkali metals increases as you go down group 1.



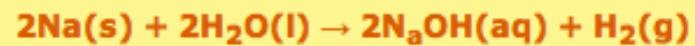
D. Alkali Metals



lithium + water → lithium hydroxide + hydrogen

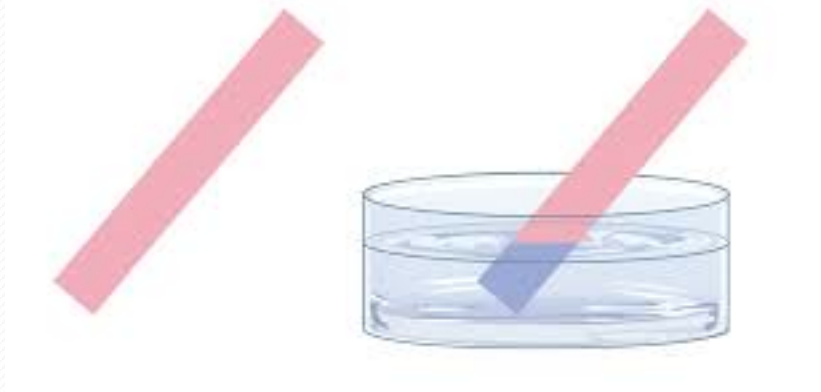


sodium + water → sodium hydroxide + hydrogen



D. Alkali Metals

- The hydroxides formed in all of these reactions dissolve in water to form alkaline solutions.
- These solutions turn universal indicator purple, showing they are strongly alkaline.
- Strong alkalis are corrosive, so care must be taken when they are used, for example, by using goggles and gloves.

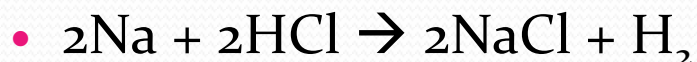


D. Alkali Metals

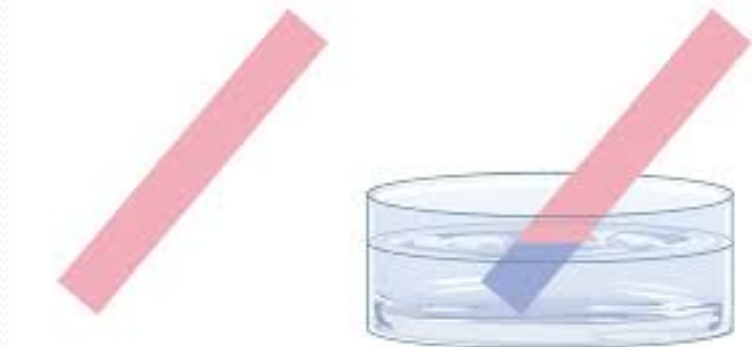
- Other reactions:

- With Acid

- Sodium + hydrochloric acid \rightarrow sodium chloride + hydrogen



- With non-metals (especially group 7)

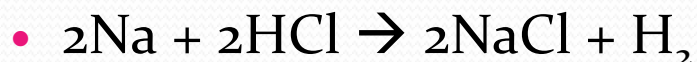


D. Alkali Metals

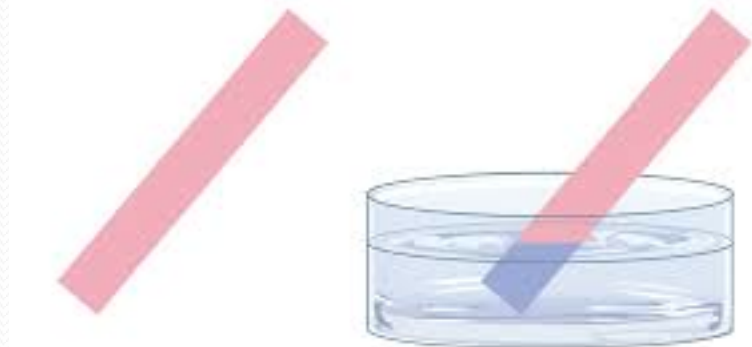
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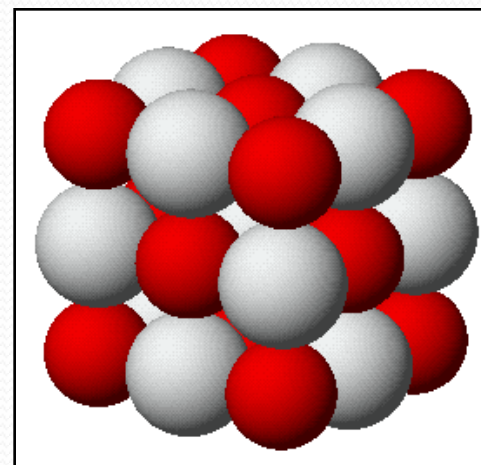
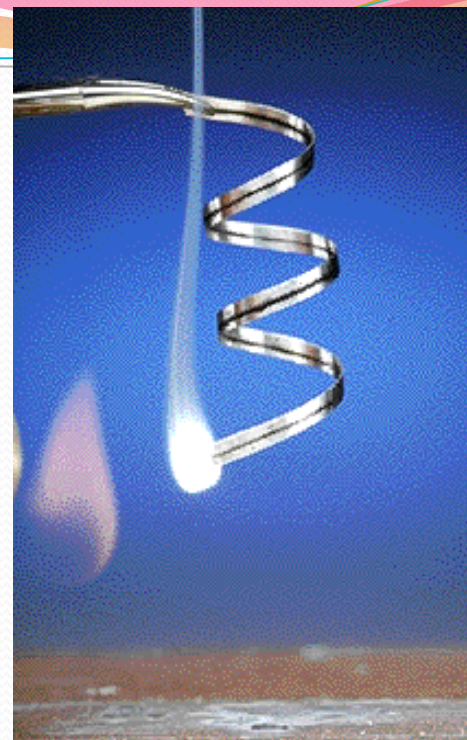


- With non-metals (especially group 7)



E. Alkaline Earth Metals

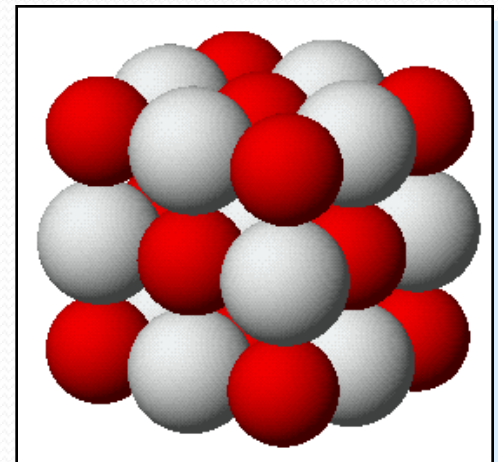
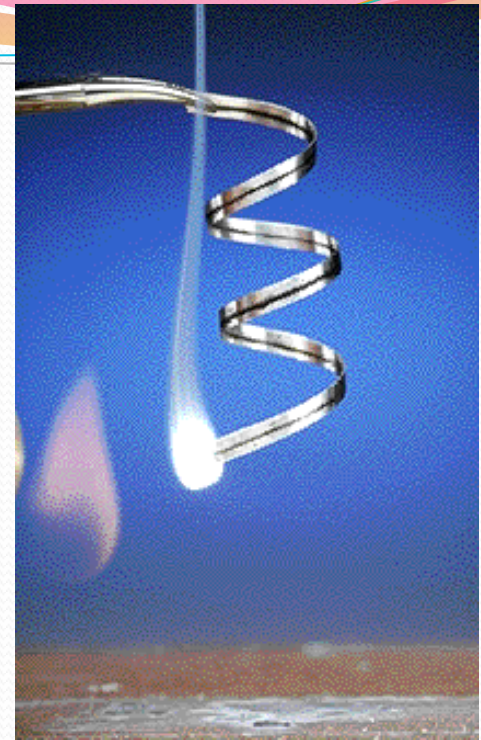
- Second column on the periodic table. (Group 2)
- Reactive metals that are always combined with nonmetals in nature.
- Less reactive than Group 1
- Several of these elements are important mineral nutrients (such as Mg and Ca)



Magnesium oxide

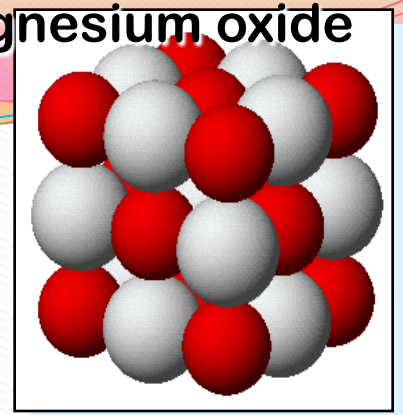
E. Alkaline Earth Metals

- Reactions:
 - With water



Magnesium oxide

E. Alkaline Earth Metals



- Reactions:

- With water

- Calcium + water \rightarrow calcium hydroxide + hydrogen
 - $\text{Ca (s)} + 2 \text{H}_2\text{O (l)} \rightarrow 2 \text{Ca(OH)}_2\text{(aq)} + \text{H}_2 \text{ (g)}$

- With acids

- Magnesium + hydrochloric acid \rightarrow magnesium chloride + hydrogen
 - $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$

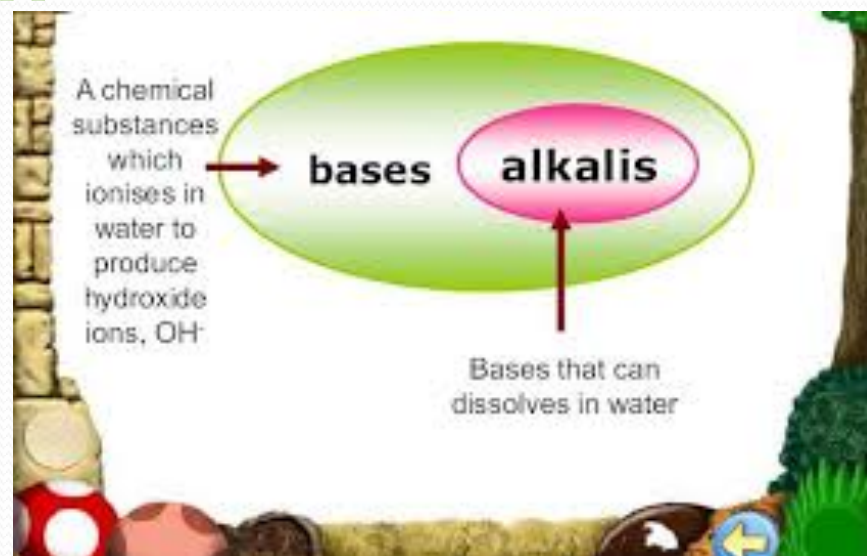
- With non-metals

- Magnesium + oxygen \rightarrow magnesium oxide
 - $\text{Mg} + \text{O}_2 \rightarrow \text{MgO}$

Basic and Acidic Oxides

- Metal oxide reactions:

- Metal oxide + water \rightarrow alkali
- Example:
 - $\text{Na}_2\text{O (s)} + \text{H}_2\text{O (l)} \rightarrow 2 \text{NaOH (aq)}$
- Some metal oxides don't dissolve in water (we call them bases)
- All metal oxides are bases. The soluble ones are called alkalis.
- All oxides will react with acid
- Example of bases: iron oxide, copper oxide



Basic and Acidic Oxides

- Non-metal oxide reactions:
 - Non-metal oxide + water \rightarrow acid
 - Example:
 - $\text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{l}) \rightarrow \text{H}_2\text{CO}_3 (\text{aq})$
 - Some metal oxides don't dissolve in water (we call them bases)
 - All metal oxides are bases. The soluble ones are called alkalis.
 - All oxides will react with acid
 - Example of bases: iron oxide, copper oxide

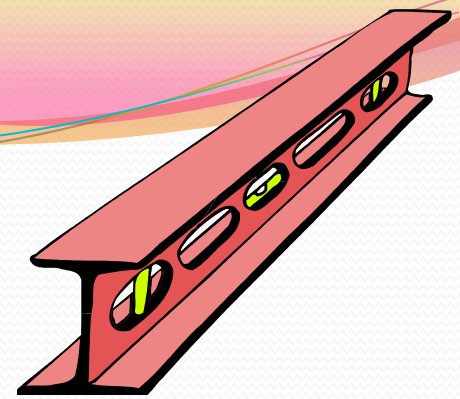
Basic and Acidic Oxides

- How about semi-metal oxides and water? Produce acid or base??

Basic and Acidic Oxides

- How about semi-metal oxides and water? Produce acid or base??
- They are amphoteric. They can behave as metal oxides and non-metal oxides.

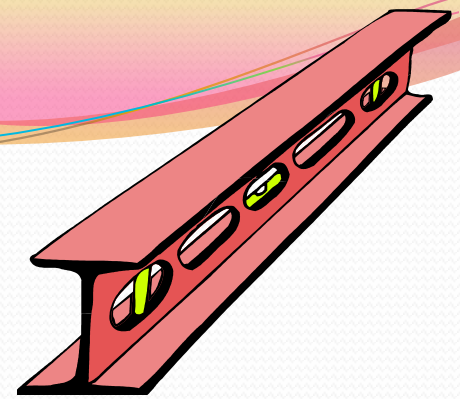
F. Transition Metals



- Elements in groups 3-12
- Less reactive than groups 1 and 2
- Hard, dense, and shiny metals
- Good conductors of heat and electricity
- Malleable and ductile
- High boiling and melting points
- Iron, cobalt, and nickel are magnetic
- Includes metals used in jewelry and construction.



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- Iron, cobalt, and nickel are magnetic
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F. Transition Metals

Copper (I) oxide



Copper (II) oxide



- Chemical properties:
 - Less reactive than groups 1 and 2
 - React slowly with oxygen
 - Copper + oxygen \rightarrow copper oxide
 - React very slowly, if at all, with water
 - They are colored compounds
 - They have more than one formula
 - Example: Copper oxide, iron oxide
 - Used in industries as catalyst to speed up reactions



F. Transition Metals

Copper (I) oxide



- Read pages 44 and 45, 48 and 49
- Solve page 50+51 (all)

Copper (II) oxide



Groups of non-metals

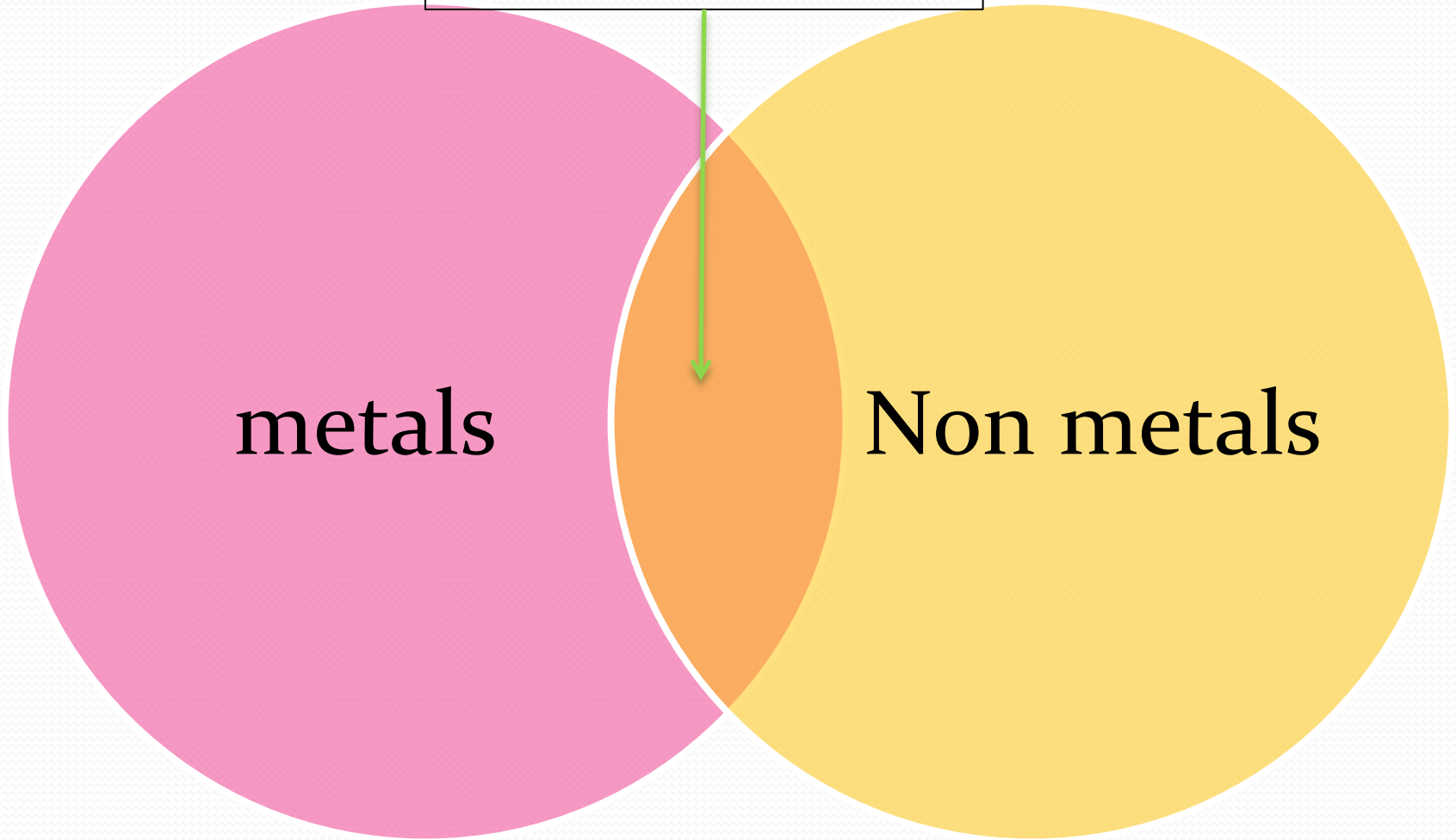
Chapter 5

Properties of metals VS non metals

What's in between?

metals

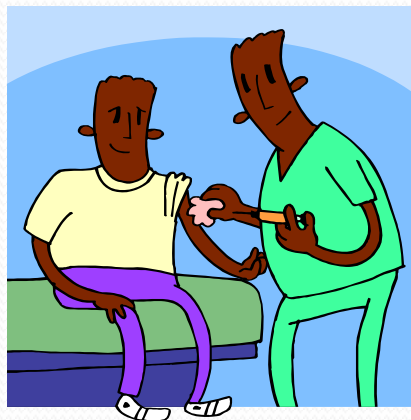
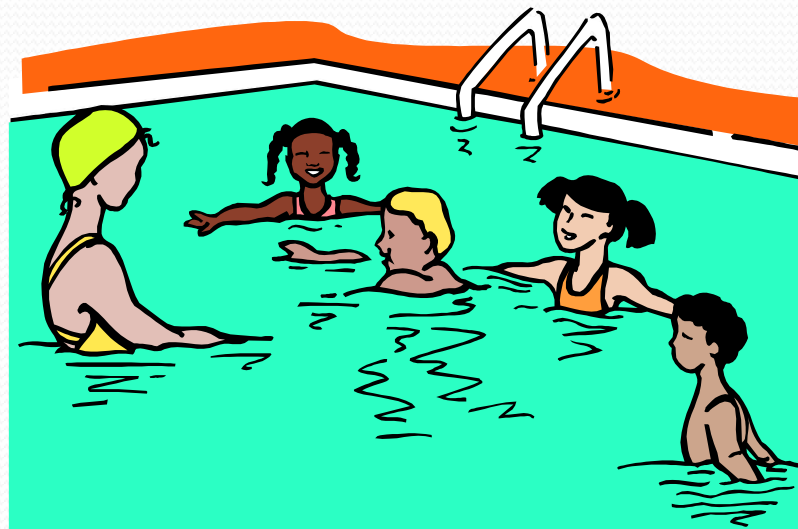
Non metals



| METALS | NONMETALS |
|--|--|
| Metals are generally solids. (exception : mercury, gallium) | Nonmetals are found in all three states. |
| Metals are heavy. (exception : sodium, potassium, magnesium) | Nonmetals are generally light in weight. |
| They are hard and nonbrittle. (exception : sodium, potassium and lead which are soft) | Solid nonmetals are hard but brittle. |
| They are good conductors of heat and electricity. (exception : lead) | They are bad conductors of heat and electricity.(except graphite) |
| They are ductile and malleable. | They are neither ductile nor malleable. |
| Their melting point and boiling point are generally high. | Their melting point and boiling point are generally low. |
| They generally produce ringing sound on collision. | They do not produce ringing sound. |
| They are generally lustrous and can be polished. | They are generally non-lustrous and cannot be polished. |

G. Halogens

- Elements in group 7
- Very reactive, volatile, diatomic, nonmetals
- Always found combined with other element in nature.
- Used as disinfectants and to strengthen teeth.

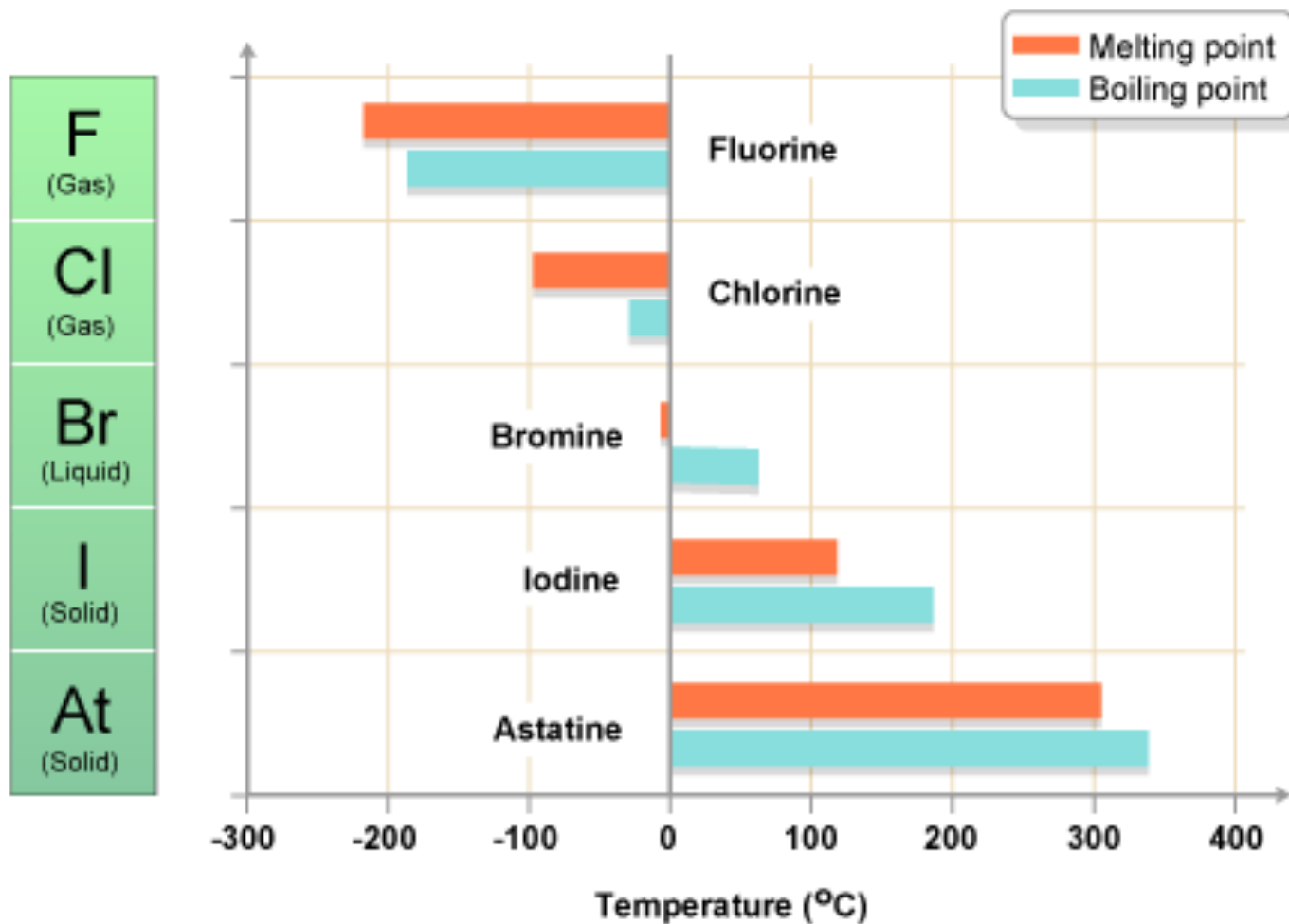


G. Halogens


| Halogen molecule | color | state |
|------------------|--------------|--------|
| F ₂ | Pale yellow | gas |
| Cl ₂ | Yellow/green | gas |
| Br ₂ | Orange/brown | liquid |
| I ₂ | Grey/black | solid |

- What pattern do you see
 - in their color?
 - State?
 - Melting and boiling points?
- Predict some properties of astatine

G. Halogens

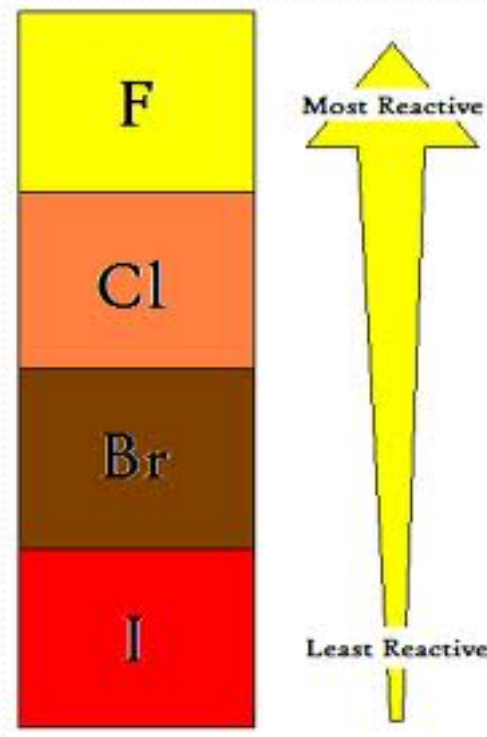


G. Halogens

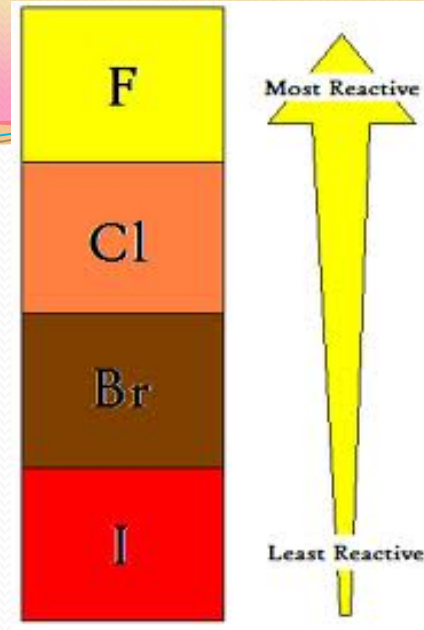
| | | | | | |
|---|----|------------------------------|--|--|--|
| Gas | F | ↑ Volatility increases | ↑ Solubility in water increases | ↓ Melting & boiling point increases | ↑ Increase in strength of oxidising agent |
| Gas | Cl | | | | |
| Liquid | Br | | | | |
| Solid | I | | | | |
|  | At | | | | |

G. Halogens reactivity

- Reactivity decreases as you go down the group
- Halogen form halides.
- Chlorine is more reactive than iodine and bromine
- Chlorine displaces (push out) bromide and iodide out of solution
 - $\text{Cl}_2(\text{aq}) + 2\text{KBr}(\text{aq}) \rightarrow 2\text{KCl}(\text{aq}) + \text{Br}_2(\text{aq})$
- Can bromine displace iodine?



G. Halogens reactivity



- Chlorine reactions

- With water

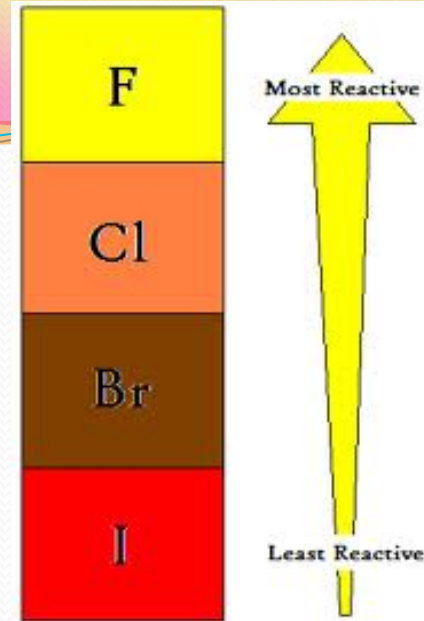
- Used as bleach
- Chlorine + water \rightarrow hydrochloric acid + chloric acid (bleach)
- Bromine is less acidic and is a weak bleach

- With iron

- Reacts vigorously
- $\text{Fe(s)} + \text{Cl}_2\text{(g)} \rightarrow 2\text{FeCl}_3\text{(s)}$

G. Halogens reactivity

- Read pages 54 – 55



H. The Noble Gases

- Elements in group 8
- monatomic gases
- they are colourless
- Used in lighted “neon” signs
- VERY unreactive, why?



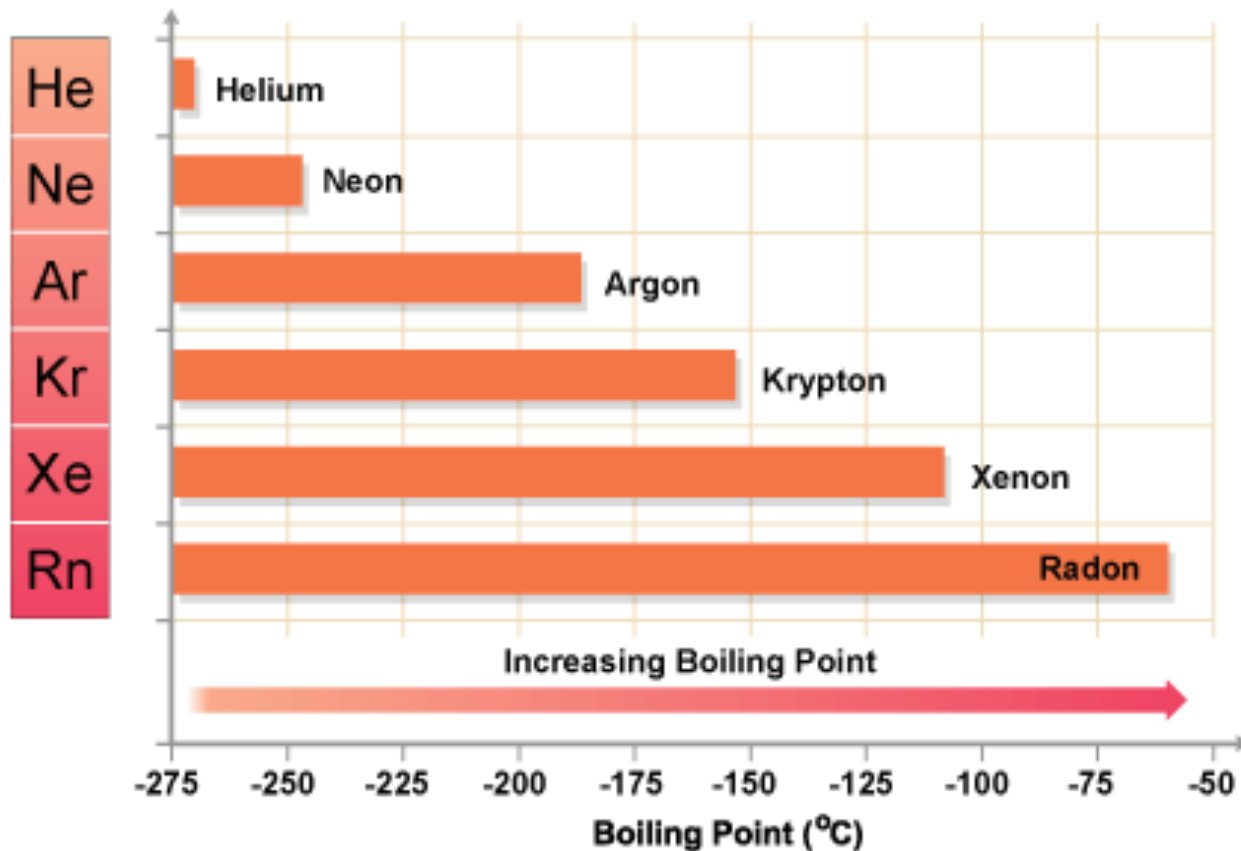
H. The Noble Gases

- VERY unreactive, why?
 - Have a full valence shell.
- Noble gases are stable because they have a full outer shell



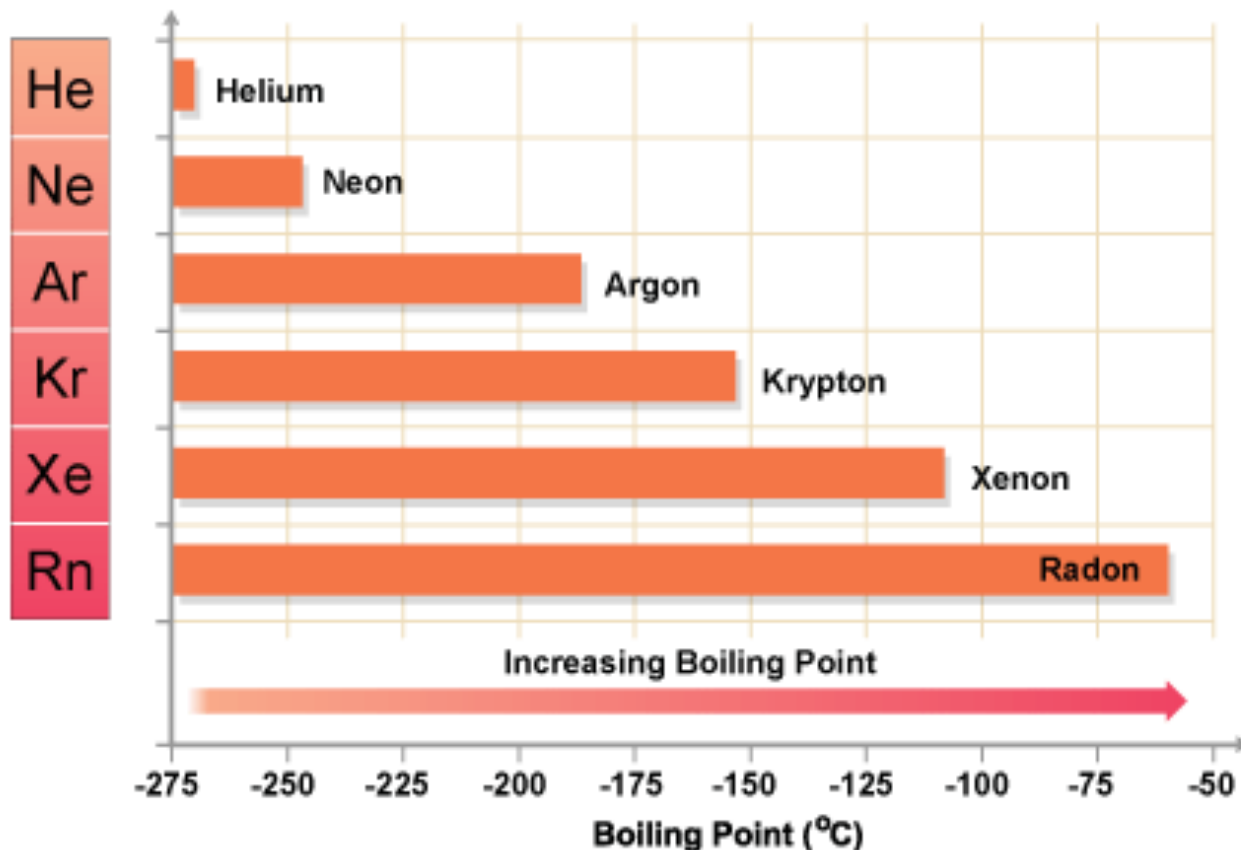
H. The Noble Gases

- What do you notice happens to the boiling point as you go down a group?



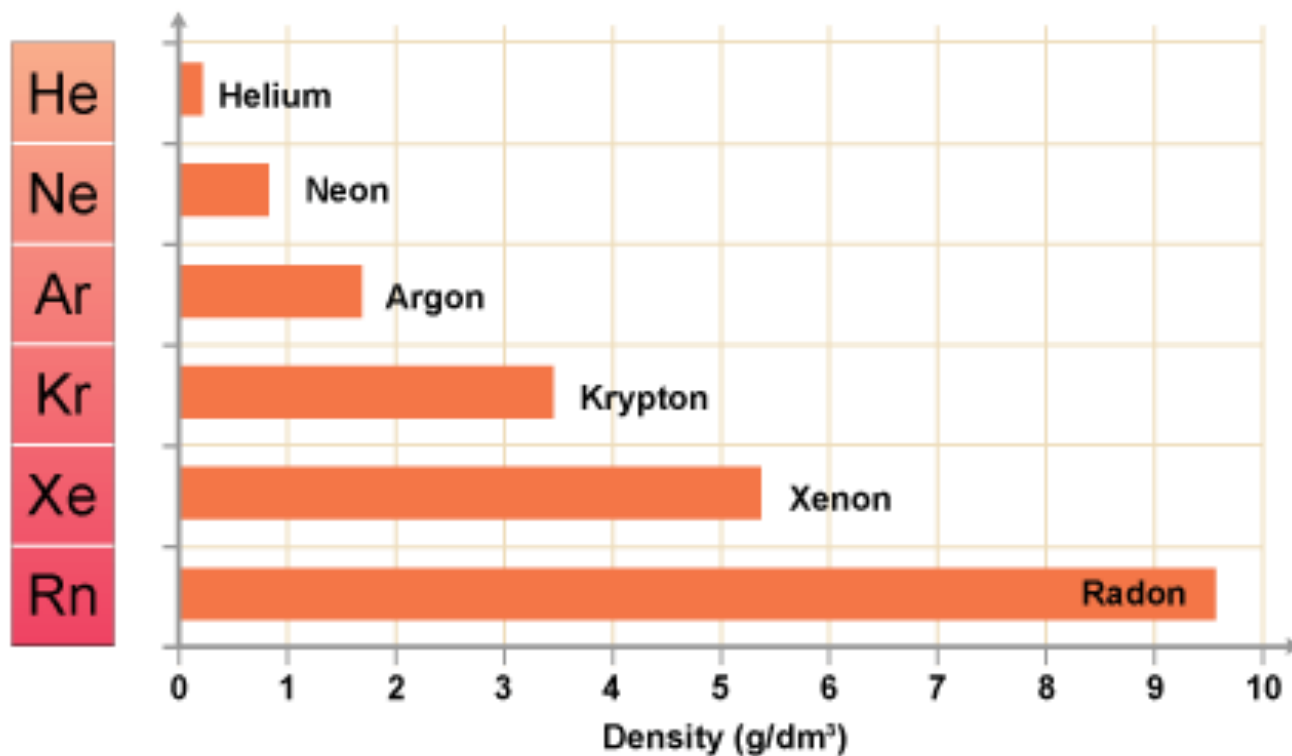
H. The Noble Gases

- Forces between molecules get stronger as the molecule gets larger



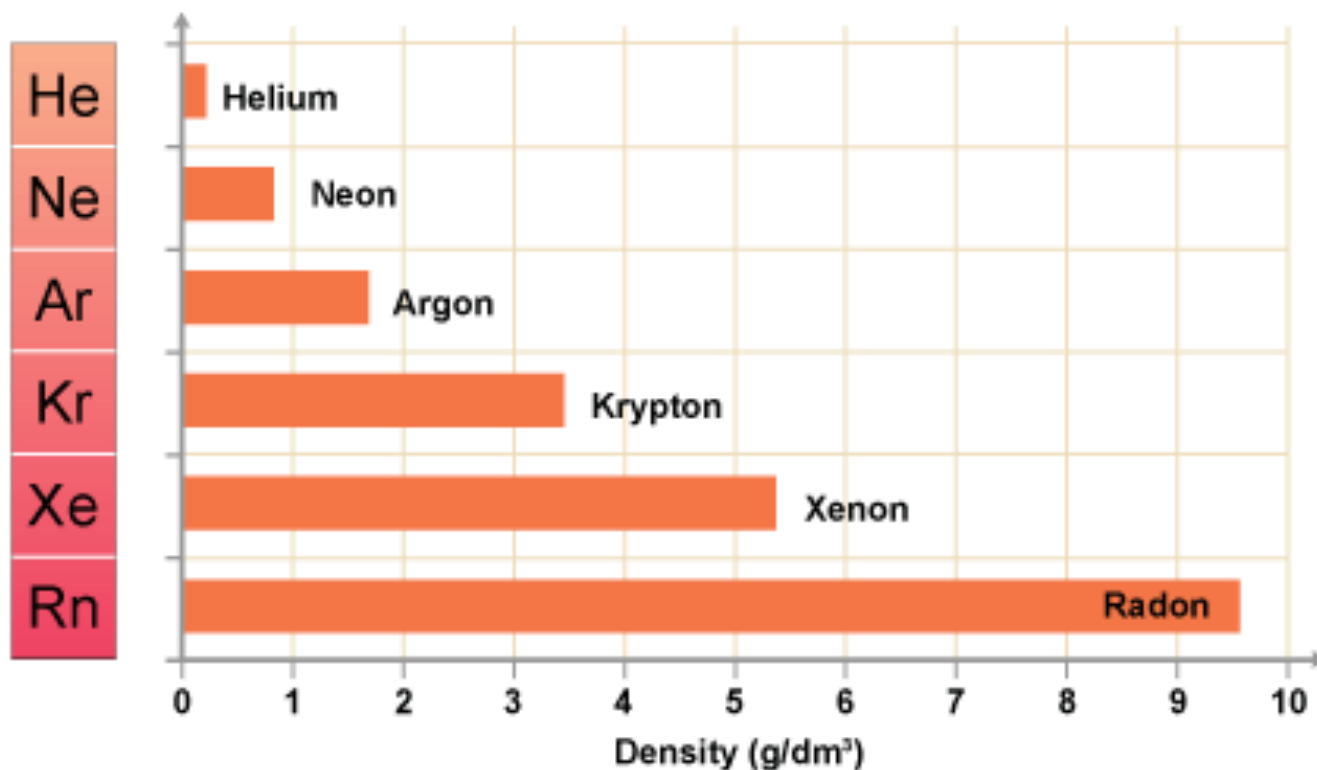
H. The Noble Gases

- The density of a substance is a measure of how heavy it is for its size. ($D = m/V$)
- Explain the trend below.



H. The Noble Gases

- The particles in gases are spread far apart, so gases have low densities.



H. The Noble Gases

- Read pages 58 - 59





QUESTION: Predict the reactivity of Alkali, Alkali Earth Metals, and Halogens down a column.



<http://wiki.oneschool.net/images/thumb/4/4e/GraphHeating.png/400px-GraphHeating.png>

<http://science.pppst.com/chemistry.html>

http://upload.wikimedia.org/wikipedia/commons/0/0e/Simple_chem_distillation.PNG

http://www.chem4kids.com/files/elements/art/020_orbital.gif

<http://www.dallasd.com/our%20schools/high%20school/chemsite/isotopes/quiz2.htm>

<http://www.chem.ox.ac.uk/vrchemistry/chapter6/Images/orbitdiagram1.jpg>

[http://www.antonine-education.co.uk/Physics AS/Module 1/Topic 1/topic 1.htm](http://www.antonine-education.co.uk/Physics_AS/Module_1/Topic_1/topic_1.htm)